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4/30/00

Tevatron Flying Wire OAC Specifications

modified by M. Church 2/27/03

General Overview :

There has been much discussion about the method of the final calculations for the Tevatron emmittances and lifetimes derived from tevatron instrumentation. Currently these parameters are calculated in the Instrunment front ends are then in turn presented as ACNET parameters. Upon last discussions and meetings with Tevatron, Instrumentation and Contronls Departements is was suggested that an Open Access Client (OAC) be created called *TEVINS.* This TEVINS OAC would take inputs from various Tevatron instrument front ends and perform calculations for beam emmitance, partical (proton & pbar) and luminosity lifetimes , and calculated luminosities for CDF and D0 of Tevatron beam during stores and through the shot setup process. This OAC will be developed and maintained for all eternity by Brain Hendricks.

Calculated Devices (output) from the OAC :

The desire would be to have the OAC calculate a set of Tevatron accelerator parameters derived from many different existing tevatron instruments. This set of calculated devices would be ACNET devices “owned” by the proposed Tevatron TEVINS OAC. The OAC would be expected to calculate the following devices:

1) Horizontal Emittance for each 36 proton and pbar bunches and average. ε_h
2) Vertical Emittance for each 36 proton and pbar bunches and average. ε_v
3) Longitudinal Emittance for each 36 proton and pbar bunches and average. ε_p
4) Predicted Luminosity from above emittances for each 36 bunches and average at B0 .
5) Predicted Luminosity from above emittances for each 36 bunches and average at D0.
6) Predicted average and 36 for proton and pbar ε_h and ε_v calculated from real time luminosity and intensity parameters.
7) σ_p/p for all bunches
8) Hourglass factor for 36 collisions at D0 and average.
9) Hourglass factor for 36 collisions at B0 and average.
10) Emittance blow-up @ 150 GeV, all 3 dimensions, for each bunch.
11) Emittance blow-up on the ramp, all 3 dimensions, for each bunch.
12) Should we include lifetime calculations (intensity, emittance, luminosity) in this OAC?

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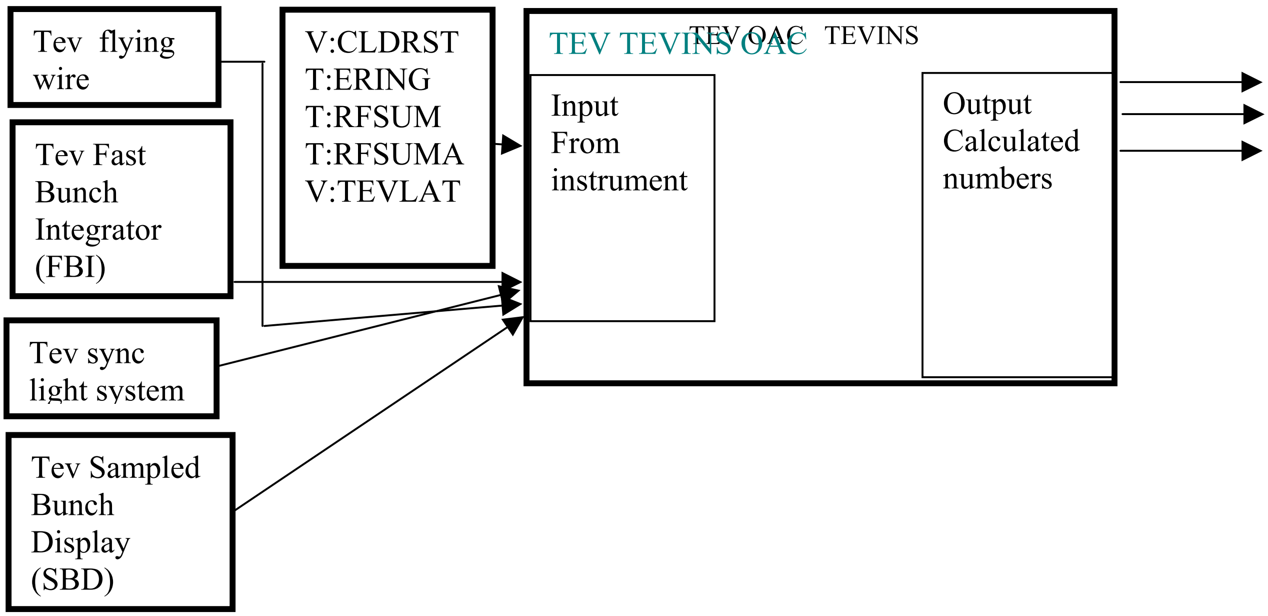

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Flying Wire front-end inputs

1) horizontal sigmas from pass 1 and pass 2 from E11 and E17 wires
2) vertical sigma from pass 1 and pass 2 from E11 wire
3) chi-square parameter for all fits
4) freshness parameter
5) time-stamp of fly (if it doesn't exist, make request to Flora)

SBD front-end inputs

1) intensity for each bunch
2) sigma from 5 parameter gaussian fit for each bunch
3) chi-square for above fits (if it doesn't exist, make request to Flora)
4) RMS width for each bunch
5) time-stamp of measurement (if it doesn't exist, make request to Flora)
6) <u>Note:</u> A single parameter (sigma, RMS, …) is certainly not adequate to characterize the longitudinal structure of the beam. Eventually the SBD front-end will have to incorporate a more elaborate algorithm. My own feeling is that 2 or 3 parameters will be adequate.

FBI front-end inputs

1) intensity for each bunch

Synch Lite front-end inputs

I am not familiar with this device.

"Calculational" inputs

1) Where should lattice functions (dispersion, beta functions, slip factor) be calculated? The lattice functions in the database are certainly not yet accurate enough for emittance calculations.
2) T:ERING is ok for energy.
3) T:RFSUM and T:RFSUMA probably need a correction (I believe a readback of 1.1MV corresponds to a real voltage of 1.05MV)
4) V:CLDRST, C:LBSEQ
5) dE/dt – can be calculated from T :MDAT11
6) F_0 – internal lookup table based on T:ERING
7) Internal calculational constants (for hourglass factor, SBD cable correction, FBI intensity correction, polynomial expansions for longitudinal emittance calculation, …..)

Other front-end inputs

Should be left open for new devices. For example, MI instrumentation front-ends or BLT front-ends. Also, E17 Schottky parameters. It may be interesting to calculate emittance blowup on MI→Tev transfers, or beam loss on MI→Tev transfers. It may be interesting to calculate how much of the emittance blowup is due to injection steering errors, which would require Tev BLT data.

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Data synchronization

Getting all front-end data properly synchronized will not be trivial. Some data is available on "$event+delay" (FW), while some data is available on request (FBI). Programmer will have to work closely with operations specialist to set this up correctly. Probably this program will be sensitive to operational changes, and attention will need to be paid to this fact. A more specific flow chart on data collection needs to be made before this program can be written.

Calculational algorithms

1) Start with MDC algorithm for calculating σ_p/p and longitudinal emittance from the SBD data, until a better algorithm arrives. There are two possibilities: a) use the gaussian fit parameter, with no cable correction; b) use the RMS parameter with an additional cable correction. This algorith works at 150 GeV and 980 GeV but has not been developed for up the ramp. A simple algorithm needs to be devoped for calculations on the ramp.
2) Start with the MDC algorithm for calculating transverse emittance (using σ_p/p from the SBD). The accuracy here is currently limited by knowledge of beta and dispersion functions.
3) Synch Lite. ??

SDA

There may be an initial problem here. Currently there is barely enough time in the Inject Protons Sets to get the FW data into SDA before the next Set begins. Time may run out before the OAC can collect data, process it, and then be read into SDA. (When will the faster FW front-end become operational?) Alternative is to save the OAC output data in arrays and write a big chunk of it at end of Remove Halo Case.

Output ACNET Device Name

Each of the new output devices should have the following charateristics:

- The devices should be array devices that are 37 elements long. The 0^{th} element or [0] should contain the average value of rest of he 36 elements.
- [1] –[36] of the array device should contain the indvidual bunch information.

The names of the these output devices should be as follows:

1) Horizontal Emittance :

Proton:	T:PHE[1] – [36]	Average proton horizontal emittance = T:PHE[0]
Pbar:	T:AHE[1] – [36]	Average proton horizontal emittance = T:AHE[0]

2) Vertical Emittance :

Proton:	T:PVE[1] – [36]	Average proton horizontal emittance = T:PVE[0]
Pbar:	T:AVE[1] – [36]	Average proton horizontal emittance = T:AVE[0]

3) Longitudinal Emittance :

Proton:	T:PPE[1] – [36]	Average proton horizontal emittance = T:PPE[0]
Pbar:	T:APE[1] – [36]	Average proton horizontal emittance = T:APE[0]

4) B0 Luminosity :
   T:LUMB0[1] – [36]   Average B0 luminosity = T:LUMB0[0]

5) D0 Luminosity :
   T:LUMD0[1] – [36]   Average D0 luminosity = T:LUMD0[0]

Equations to use for Calculation of Output Devices :

The following CLIB routines can be used to calculate the transverse and longitudal emmittance values. These should be verified by Mike Martens. If further equations are needed Mike will provide them.

1. Horizontal Emittance for each 36 proton and pbar bunches. ε_h
   There is the function *emitt_dp( )* in physlib that can be used to calculate this parameter.

2. Vertical Emittance for each 36 proton and pbar bunches. ε_v
   There is the function *emitt_dp( )* in physlib that can be used to calculate this parameter.

3. Longitudinal Emittance for each 36 proton and pbar bunches ε_p

4. Predicted Luminosity from above emittances for each 36 bunches at B0
   There is the function *calc_lum( )* in physlib that can be used to calculate this parameter.

5. Predicted Luminosity from above emittances for each 36 bunches at D0.
   There is the function *calc_lum( )* in physlib that can be used to calculate this parameter.

Additional Devices owned by TEVINS to Calculate Output Devices :

It will be neccassary for the OAC to own some additional ACNET parameters to help define the mapping between input parameters and calculation of output parameters. This section still needs some more refinement but in general there will need to be some of the following parameters.

T:XXXSpH [0-NUM_STATES] = Instrument value
T:XXXSpV [0-NUM_STATES] = Instrument value
T:XXXXBL [0-NUM_STATES] = Instrument value
T:XXXXDP [0-NUM_STATES] = Instrument value
T:XXXXEN [0-NUM_STATES] = Instrument value
T:XXXLAT [0-NUM_STATES] = Instrument value

Where:
P = P for proton, A for pbar.

Instrument value =
1 = Flying wire,
2 = sync light,
3 = SBD,
4 = FBI
5 = Study parameters.

NUM_STATES = 1-24 or number of states for V:CLDRST

Input Devices to be used for Calculated OAC Devices :

The input devices come from existing tevatron instructs that the OAC will read and make calculations from. Most of these input devices are ACNET device but some are obtained from database queries. The following is the set of Input devices that will be needed to make all necessary calculations.

1) Flying wire horizontal sigmas for all 36 proton and pbar bunches for given tevatron state.
2) Flying wire vertical sigma for all 36 proton and pbar bunches for given tevatron state.
3) Flying wire longitudinal sigmas for all 36 proton and pbar bunches for given tevatron state.
4) The proton and pbar Total intensities from the FBI system.
5) The proton and pbar intensities from the FBI system for each 36 bunches.
6) The proton and pbar intensities from the SBD system for each 36 bunches.
7) The average proton and pbar bunch lengths from the SBD system.
8) The RF sum for both proton and pbar cavities.
9) The 16 Tevatron lattices obtained from database and index from V:TEVLAT.
10) The energy of the tevatron.
11) The "state" of the tevatron reflected by the state device C:CLDRST.

Input Device Names :

The following device names

Function	ACNET NAME	FTD	Number of Array elements	Description
FW Proton hor sigma	T:FWHPSG	state trans	72	pass 1 and 2
FW Proton ver sigma	T:FWVPSG	state trans	72	pass 1 and 2
FW Pbar hor sigma	T:FWHASG	state trans	72	
FW Pbar ver sigma	T:FWVASG	state trans	72	
FBI proton intensity	C:FBIPNG	1 HZ	37	
FBI pbar intensity	C:FBIANG	1 HZ	37	
SBD Proton bunch length	T:SBDPSS	1 HZ	37	
SBD Pbar bunch length	T:SBDASS	1 HZ	37	
SL Proton hor sigma	T:SLPESX	0.1 HZ	36	
SL Proton ver sigma	T:SLPESY	0.1 HZ	36	
SL Pbar hor sigma	T:SLAESX	0.1 HZ	36	
SL Pbar ver sigma	T:SLAESY	0.1 HZ	36	
RF sum protons	T:RFSUM	1 HZ	NA	
RF sum pbars	T:RFSUMA	1 HZ	NA	
Tev Energy	T:ERING	1 HZ	NA	
Tev Program energy	T:IPROG	1 HZ	NA	

Which Input device to use in the calculation for output device:

Collider State	FWHσ	FWVσ	FWLσ	SyncHσ	SyncVσ	SBDPσ	Tev latt	Energy	LBSEQ
1	X	X				X	0	150	0
2	X	X				X	0	150	0
3	X	X				X	0	150	0
4	X	X				X	0	150	0
5	X	X				X	0	150	0
6	X	X				X	0	150	0
7	X	X				X	0	150	1
8	X	X				X	1	150	1
9	X	X				X	1	150-980	1
10				X	X	X	1	980	25
11				X	X	X	16	980	25
12				X	X	X	16	980	25
13				X	X	X	16	980	25
14				X	X	X	16	980	25
15	X	X				X	16	980	25
16							16	980	
17								980	
18							1	980	
19							1	150-980	
20							0	150	
21							0	150	
22							0	150	
23							0	150	

When Does OAC Read Data?

- Flying wire data is ready on any transition of the state device V:TFWRDY. (This is not yet implemented, but should be soon)
- Sync light returns data at an FTD of .1HZ.
- SBD returns data at an FTD of 1Hz.
- FBI returns data at an FTD of 1 Hz

OAC Logging for Error Diagnostics and Performance:

The OAC should provide a "standard" form of error logging and diagnosing performance that can be read and accessed from ACNET applications. Error reporting for OAC's is more critical than applications because there is

Conditions for Errors within the OAC:

Application Program Support for OAC:

There will need to be an application in which to setup the input parameters for the OAC to take and produce data. This application does not have to be very complicated. It will need to read and set the OAC owned devcies. This application will alos provide the interface for reading the

OAC error log. This application will be written by Dean Still. It will have the following attributes.

- Standard user interface.

Calculations of Predicted Luminosity :

Calculations of Predicted Emmittance from Luminosity and Intensities :

Calculations of Lifetimes :